Emissions of Volatile Organic Compounds (VOCs) from soil to the atmosphere according to agricultural land-uses. Interrelationships between SOM, microbial diversity and VOCs fluxes

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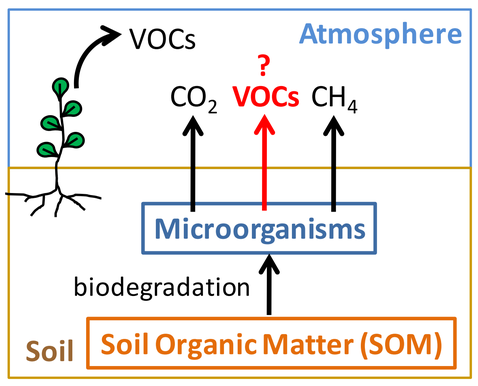
CONTEXT

Soil microorganisms are key players in soil functioning. Indeed these organisms are responsible for the decomposition of Soil Organic Matters (SOM) and deliver nutrients readily accessible to plants. While the biodegradation of SOM releases CO_2 and CH_4 to the atmosphere, it has been recently shown that microbial SOM biodegradation generates Volatile Organic Compounds (VOCs) which take part in greenhouse gases and secondary organic aerosols production. The VOC emission rates from soil to atmosphere in agricultural landscapes are still poorly documented compared to CO_2 and CH_4 fluxes.

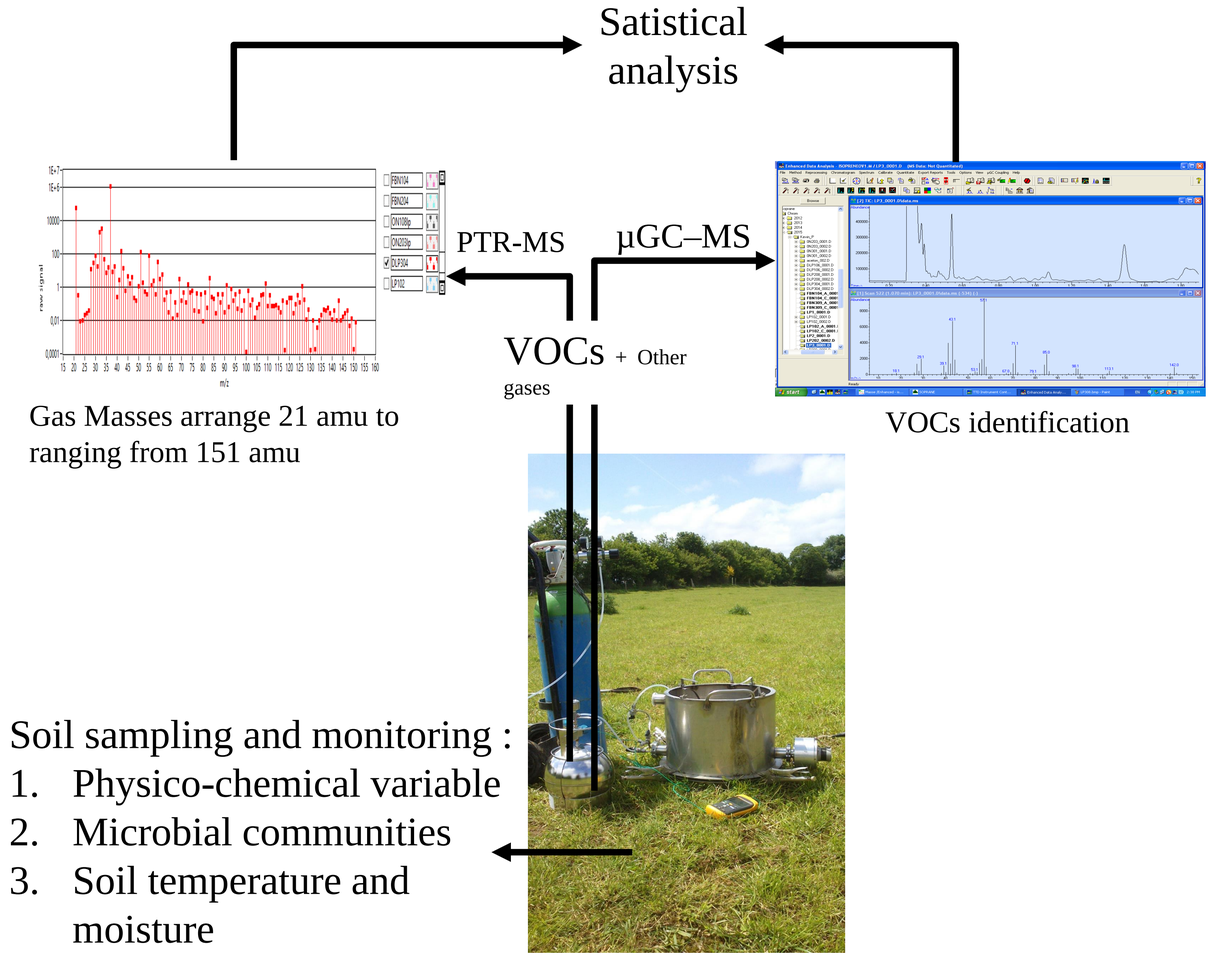


Biotic VOCs emissions

OBJECTIVES

1. **Determination of the VOC emission spectrum according to different agricultural land uses :**
   i. Conventional cropping: Organic or Mineral Nitrogen fertilization
   ii. Meadows
2. **Understand the link between SOM, active soil microorganisms and VOCs and greenhouse gases** (CO_2, N_2O, CH_4) emissions

EXPERIMENTAL STRATEGY



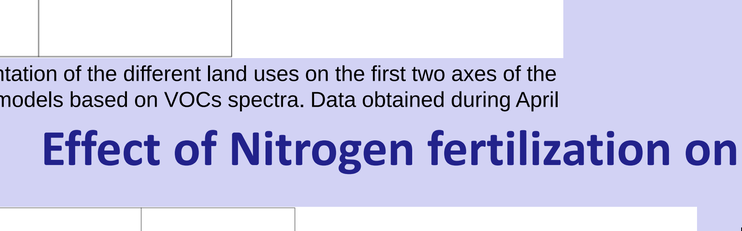
Soil sampling and monitoring :

1. Physico-chemical variable
2. Microbial communities
3. Soil temperature and moisture

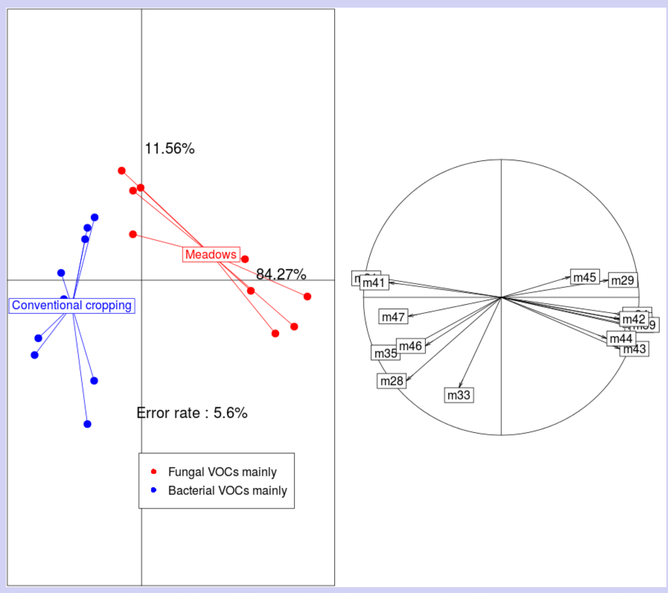
RESULTS: the main VOCs emitted by soil

Four main VOCs identified using µGC/MS and produced by soil :

Acetone, 2-butanone, 2-pentanone, **toluene** and **Methanol**



RESULTS: Effect of land uses on VOCs spectra

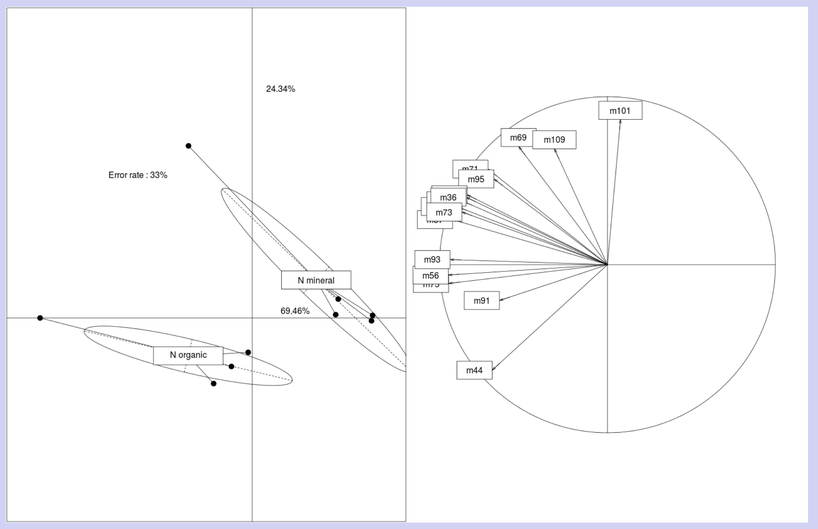


Representation of the different land uses on the first two axes of the PLS-DA models based on VOCs spectra. Data obtained during April 2015.

- Soil VOCs emissions **differed** between **meadows and conventional cropping**

- **Soil VOCs discriminants** :
  - **Meadows** : m73 (2-Butanone), m45 (acetaldehyde), m63 (dimethylsulfide) m77 (Carbon disulfide), m87 (alkane)
    - ***Mainly from Fungal***
  - **Conventional cropping** : m28, m42, m109 (2,5 dimethylpyrazine)
    - ***Mainly from Bacterial***

Effect of Nitrogen fertilization on cropped soils

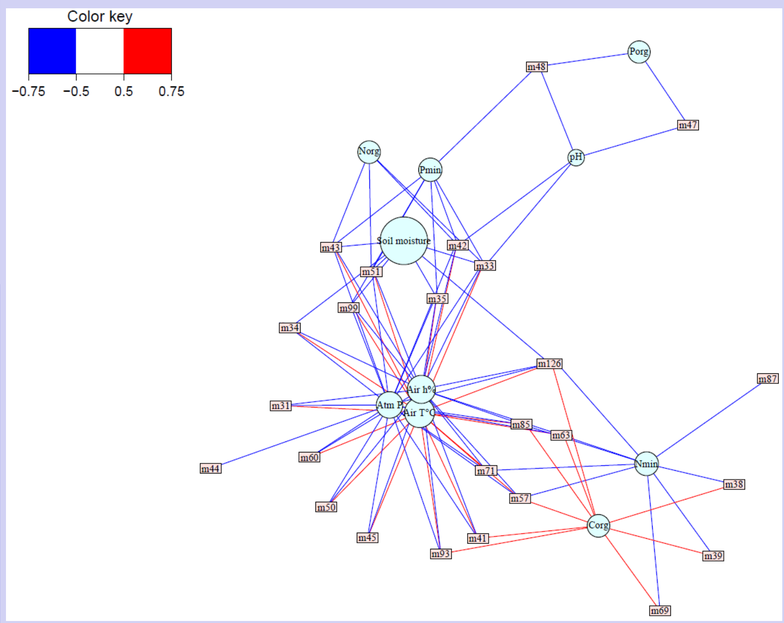


Representation of the different Nitrogen fertilization on the first two axes of the PLSDA models based on VOCs spectra from soil. Data obtained during April 2015.

- **Different** VOCs emissions according to **Nitrogen Fertilization** (Organic *vs* Mineral)

- Soil VOCs discriminant: m56 (Propanenitrile), m93 (Toluene), m75 (1 or 2-butanol), m57

Interrelationships between soil VOCs emissions and Environmental parameters



Network of Soil VOCs emissions and Environmental parameters after a PLS 2. Data obtained during March 2015.

- **Atmospheric parameters** (P, T, RH) drive **firstly** the emission of VOCs by **soil under cropped** condition

- **Soil moisture** is the **second main factor** related to soil **VOCs emissions**

- **Nutrients** are **less important factor** in this analyse to explain the VOCs emissions

Research in going

- Long term monitoring of *in situ* VOCs emission at the landscape scale
- Analysing the diversity of soil microbial communities (meta-barcoding)
- Analysing the reactive Soil Organic Matter (THM-GC-MS method)
- Explaining (SIP C^{13} RNA method) and predicting the VOCs emissions according to environmental and biological parameters (Multivariates analysis and lab incubations)

Reference

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Financial support : CNRS EC2CO « MICROCOV » & Enviromics « COVOMICS » / UE

BAGECO 13 — 13th Symposium on Bacterial Genetics and Ecology